

I CLAIM:

1 1. A system for accelerating the solution of treatment gas
2 into a liquid stream, said system being adapted to receive and
3 maintain said stream under pressure, said system comprising:

4 an aspirating injector comprising a body having an
5 axial passage, a converging section, a throat section and a
6 diverging section in said passage in that order, an injector port
7 through said body entering said throat section and adapted to
8 receive treatment gas to be dissolved in said liquid stream, said
9 passage having an inlet port to receive said stream, and an
10 outlet port;

11 a collider and a reactor, each having an inlet port and
12 an outlet port, the inlet port of one of them being connected to
13 the outlet port of the injector, its outlet port connected to the
14 inlet port of the other and; a fluid release receiving said
15 stream from said last mentioned outlet port for releasing the
16 treated stream from the system while maintaining the system under
17 pressure.

1 2. A system according to claim 1 in which said fluid
2 release comprises a gas/liquid separator which separates and
3 releases the stream's liquid and the stream's gases which remain
4 undissolved in said liquid.

1 3. A system according to claim 2 in which said fluid
2 release further includes a regulator valve for the liquid stream.

1 4. A system according to claim 2 in which said separator
2 is a centrifugal separator.

1 5. A system according to claim 1 in which said collider
2 comprises a body forming a chamber, pair of nozzles opposing one
3 another, said stream being divided so a portion flows through
4 each said nozzle with their streams flowing toward and meeting
5 one another in said chamber, said body having an outlet port
6 exiting the chamber.

1 6. A system according to claim 5 in which said portions of
2 said stream intersect at an included angle not larger than 90
3 degrees.

1 7. A system according to claim 5 in which said portions of
2 said stream are axially aligned, and in which said exit port
3 exits the chamber laterally, midway between said nozzles.

1 8. A system according to claim 5 in which each of said
2 nozzles includes a converging section, and twisting vanes in said
3 converging section whereby to impart a rotary motion to the outer

4 region of the stream as it flows through the nozzle.

1 9. Apparatus according to claim 1 in which said reactor
2 comprises a body having a central axis with an internal
3 cylindrical wall forming an axial internal cylinder, its said
4 inlet port adapted to receive said stream, and its said outlet
5 port adapted to discharge said stream with an increased dissolved
6 amount of said treatment gas therein, said inlet port and said
7 outlet port being centrally located on said central axis;

8 a nozzle in said inlet port directing said stream
9 axially into said cylinder;

10 a partial barrier extending laterally across said
11 cylinder dividing said cylinder onto a first chamber and a second
12 chamber, said barrier having an upstream face facing into said
13 first chamber and axially facing said nozzle, and a downstream
14 face facing into said second chamber and facing said outlet port;

15 said upstream face having a concave circular first
16 reflecting surface centered on said central axis and facing said
17 nozzle, the radius of said reflecting surface being smaller than
18 the internal radius of said internal cylindrical wall;

19 a plurality of axially extending arcuate blades, each
20 having an outer wall closely fitting to said internal cylindrical
21 wall, a dimension of radial thickness, and an inner wall
22 concentric with its said outer wall, said blades having axially-

23 extending side walls, said blades being angularly spaced from one
24 another to provide an equal number of axial slots between them;
25 a cove surface circularly surrounding said first
26 nozzle, extending to said inner walls of the blades and to their
27 intersections with said slots, whereby said stream discharges
28 from said nozzle so a major portion of it strikes said reflecting
29 surface, which reverses a major portion of the flow to the cove
30 surface which in turn reflects a major portion of said flow
31 toward said barrier along said blades and in said slots, said
32 partial barrier being pierced between with slots between said
33 slots to provide for flow from said first chamber into said
34 second chamber, thereby to pass said flow from the first chamber
35 into said second chamber, said outlet port discharging from said
36 second chamber.

1 10. Apparatus according to claim 9 in which said second
2 chamber comprises a partial barrier facing toward said outlet
3 port, a plurality of blades and slots as in said first chamber,
4 said slots in the first and second chamber being rotationally
5 displaced from one another, whereby to form joggle shoulders
6 encountered by portions of the stream flowing across the
7 barriers, said second chamber including a cove receptive of some
8 of the flow across the barrier to reflect at least some of the
9 flow of the stream to the barrier in said second chamber, which

10 in turn reflects it to said outlet port.

1 11. Apparatus according to claim 10 in which said fluid
2 release comprises a gas/liquid separator which separate and
3 releases the stream's liquid and the stream's gases which remain
4 undissolved in said liquid.

1 12. Apparatus according to claim 3 in which said fluid
2 release comprises a gas/liquid separator which separate and
3 releases the stream's liquid and the stream's gases which remain
4 undissolved in said liquid.

1 13. Apparatus according to claim 11 in which said separator
2 is a centrifugal separator.

1 14. Apparatus according to claim 10 in which said collider
2 comprises a body forming a chamber, pair of nozzles opposing one
3 another, said stream being divided so a portion flows through
4 each said nozzle with their streams flowing toward and meeting
5 one another in said chamber, said body having an outlet port
6 exiting the chamber.

1 15. Apparatus according to claim 14 in which said portions
2 of said stream intersect at an included angle not larger than 90

3 degrees.

1 16. Apparatus according to claim 14 in which said portions
2 of said stream are axially aligned, and in which said exit port
3 exits the chamber laterally, midway between said nozzles.

1 17. A system for accelerating the solution of treatment gas
2 into a liquid stream, said system being adapted to receive and
3 maintain said stream under pressure, said system comprising:
4 an aspirating injector comprising a body having an
5 axial passage, a converging section, a throat section and a
6 diverging section in said passage in that order, an injector port
7 through said body entering said throat section and adapted to
8 receive treatment gas to be dissolved in said liquid stream, said
9 passage having an inlet port to receive said stream, and an
10 outlet port;

11 a collider having an inlet port and an outlet port,
12 said inlet port being connected to the outlet port of the
13 injector, its outlet port being connected to a fluid release
14 receiving said stream from said last mentioned outlet port for
15 releasing the treated stream from the system while maintaining
16 the system under pressure.

1 18. A system according to claim 17 in which said collider

2 comprises a body forming a chamber, pair of nozzles opposing one
3 another, said stream being divided so a portion flows through
4 each said nozzle with their streams flowing toward and meeting
5 one another in said chamber, said body having an outlet port
6 exiting the chamber.

1 19. A system according to claim 18 in which said portions
2 of said stream intersect at an included angle not larger than 90
3 degrees.

1 20. A system according to claim 18 in which said portions
2 of said stream are axially aligned, and in which said exit port
3 exits the chamber laterally, midway between said nozzles.

1 21. A system for accelerating the solution of treatment
2 gas into a liquid stream, said system being adapted to receive
3 and maintain said stream under pressure, said system comprising:
4 an aspirating injector comprising a body having an
5 axial passage, a converging section, a throat section and a
6 diverging section in said passage in that order, an injector port
7 through said body entering said throat section and adapted to
8 receive treatment gas to be dissolved in said liquid stream, said
9 passage having an inlet port to receive said stream, and an
10 outlet port;

11 a reactor having an inlet port and an outlet port, the
12 inlet port being connected to the outlet port of the injector,
13 its outlet port connected to a fluid release receiving said
14 stream from said last mentioned outlet port for releasing the
15 treated stream from the system while maintaining the system under
16 pressure.

1 22. A system according to claim 21 in which said fluid
2 release comprises a gas/liquid separator which separates and
3 releases the stream's liquid and the stream's gases which remain
4 undissolved in said liquid.

1 23. A system according to claim 22 in which said fluid
2 release further includes a regulator valve for the liquid stream.

1 24. Apparatus according to claim 21 in which said reactor
2 comprises a body having a central axis with an internal
3 cylindrical wall forming an axial internal cylinder, its said
4 inlet port adapted to receive said stream, and its said outlet
5 port adapted to discharge said stream with an increased dissolved
6 amount of said treatment gas therein, said inlet port and said
7 outlet port being centrally located on said central axis;

8 a nozzle in said inlet port directing said stream
9 axially into said cylinder;

10 a partial barrier extending laterally across said
11 cylinder dividing said cylinder onto a first chamber and a second
12 chamber, said barrier having an upstream face facing into said
13 first chamber and axially facing said nozzle, and a downstream
14 face facing into said second chamber and facing said outlet port;

15 said upstream face having a concave circular first
16 reflecting surface centered on said central axis and facing said
17 nozzle, the radius of said reflecting surface being smaller than
18 the internal radius of said internal cylindrical wall;

19 a plurality of axially extending arcuate blades, each
20 having an outer wall closely fitting to said internal cylindrical
21 wall, a dimension of radial thickness, and an inner wall
22 concentric with its said outer wall, said blades having axially-
23 extending side walls, said blades being angularly spaced from one
24 another to provide an equal number of axial slots between them;

25 a cove surface circularly surrounding said first
26 nozzle, extending to said inner walls of the blades and to their
27 intersections with said slots, whereby said stream discharges
28 from said nozzle so a major portion of it strikes said reflecting
29 surface, which reverses a major portion of the flow to the cove
30 surface which in turn reflects a major portion of said flow
31 toward said barrier along said blades and in said slots, said
32 partial barrier being pierced between with slots between said
33 slots to provide for flow from said first chamber into said

34 second chamber, thereby to pass said flow from the first chamber
35 into said second chamber, said outlet port discharging from said
36 second chamber.

1 25. Apparatus according to claim 24 in which said second
2 chamber comprises a partial barrier facing toward said outlet
3 port, a plurality of blades and slots as in said first chamber,
4 said slots in the first and second chamber being rotationally
5 displaced from one another, whereby to form joggle shoulders
6 encountered by portions of the stream flowing across the
7 barriers, said second chamber including a cove receptive of some
8 of the flow across the barrier to reflect at least some of the
9 flow of the stream to the barrier in said second chamber, which
10 in turn reflects it to said outlet port.

1 26✓ A collider receptive of two streams of a gas/liquid
2 stream to accelerate the solution of the gas into the liquid,
3 said collider comprising:

4 a body forming a chamber, pair of nozzles opposing one
5 another, said stream being divided so a portion flows through
6 each said nozzle with their streams flowing toward and meeting
7 one another in said chamber, said body having an outlet port
8 exiting the chamber.

1 27. A collider according to claim 26 in which said portions
2 of said stream intersect at an included angle not larger than 90
3 degrees.

1 28. A collider according to claim 26 in which said portions
2 of said stream are axially aligned, and in which said exit port
3 exits the chamber laterally, midway between said nozzles.

1 29. A collider according to claim 26 in which each of said
2 nozzles includes a converging section, and twisting vanes in said
3 converging section whereby to impart a rotary motion to the outer
4 region of the stream as it flows through the nozzle.

1 30. A reactor receptive of a stream of liquid and bubbles
2 of treatment gas, for accelerating the solution of said gas in
3 said liquid, said reactor comprising:

4 a body having a central axis with an internal
5 cylindrical wall forming an axial internal cylinder, its said
6 inlet port adapted to receive said stream, and its said outlet
7 port adapted to discharge said stream with an increased dissolved
8 amount of said treatment gas therein, said inlet port and said
9 outlet port being centrally located on said central axis;

10 a nozzle in said inlet port directing said stream

11 axially into said cylinder;

12 a partial barrier extending laterally across said
13 cylinder dividing said cylinder onto a first chamber and a second
14 chamber, said barrier having an upstream face facing into said
15 first chamber and axially facing said nozzle, and a downstream
16 face facing into said second chamber and facing said outlet port;

17 said upstream face having a concave circular first
18 reflecting surface centered on said central axis and facing said
19 nozzle, the radius of said reflecting surface being smaller than
20 the internal radius of said internal cylindrical wall;

21 a plurality of axially extending arcuate blades, each
22 having an outer wall closely fitting to said internal cylindrical
23 wall, a dimension of radial thickness, and an inner wall
24 concentric with its said outer wall, said blades having axially-
25 extending side walls, said blades being angularly spaced from one
26 another to provide an equal number of axial slots between them;

27 a cove surface circularly surrounding said first
28 nozzle, extending to said inner walls of the blades and to their
29 intersections with said slots, whereby said stream discharges
30 from said nozzle so a major portion of it strikes said reflecting
31 surface, which reverses a major portion of the flow to the cove
32 surface which in turn reflects a major portion of said flow
33 toward said barrier along said blades and in said slots, said
34 partial barrier being pierced between with slots between said

35 slots to provide for flow from said first chamber into said
36 second chamber, thereby to pass said flow from the first chamber
37 into said second chamber, said outlet port discharging from said
38 second chamber.

1 31. A reactor according to claim 30 in which said second
2 chamber comprises a partial barrier facing toward said outlet
3 port, a plurality of blades and slots as in said first chamber,
4 said slots in the first and second chamber being rotationally
5 displaced from one another, whereby to form joggle shoulders
6 encountered by portions of the stream flowing across the
7 barriers, said second chamber including a cove receptive of some
8 of the flow across the barrier to reflect at least some of the
9 flow of the stream to the barrier in said second chamber, which
10 in turn reflects it to said outlet port.

1 32. A reactor according to claim 31 in which said fluid
2 release comprises a gas/liquid separator which separate and
3 releases the stream's liquid and the stream's gases which remain
4 undissolved in said liquid.